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Description

REMOVABLE REFRIGERATION CASSETTE FOR A HOT AND COLD VENDING MACHINE

[0001] *TECHNICAL FIELD*

[0002] The present invention relates generally to refrigeration and heating systems and more specifically relates to a removable refrigeration cassette for use with a vending machine with hot and cold vending compartments.

[0003] *BACKGROUND OF THE INVENTION*

[0004] Hot and/or cold vending machines are common in certain countries. For example, such vending machines are particularly popular in Japan. These vending machines typically have several compartments that can be run either hot or cold. The vending machines generally use a standard Rankine cycle refrigeration device. The overall refrigeration system may include evaporators in each compartment connected to the Rankine cycle device by valves and re-

frigeration lines. These valves may control which evaporators are "on", thereby controlling which compartments are cold. Each of the compartments also may have a heater. The heater may be turned on in any compartment with products that are to be vended hot.

[0005] One of the drawbacks with these vending machines is that the evaporators generally are fixed within their respective compartments. Likewise, the Rankine cycle device may be fixed within the overall enclosure. Removal or replacement of the refrigeration system or the individual components therein therefore may be difficult and time consuming.

[0006] Another drawback with known hot and cold vending machines is the use of the Rankine cycle device itself. For example, a Stirling cycle cooler may be desirable as compared to a Rankine cycle device because the Stirling cycle cooler is non-polluting, efficient, and has very few moving parts. The integration of Stirling cycle coolers into conventional refrigeration cabinets, however, requires different manufacturing, installation and operational techniques as compared to those used for conventional refrigeration systems. One example of the use of a Stirling cycle cooler is shown in commonly owned U.S. Patent No. 6,581,389 B2, entitled, "Merchandiser using Slide-out Stirling Refrig-

eration Deck", incorporated herein by reference.

[0007] What is desired, therefore, is a hot and cold vending machine with an easily removable refrigeration system. Further, such a refrigeration system may be driven by a Stirling cycle cooler system, although a conventional Rankine cycle system or any type of known refrigeration system may be used.

SUMMARY OF INVENTION

[0008] The present invention thus provides a hot and cold vending machine. The vending machine may include a product compartment, a refrigeration system, and a ventilation system in communication with the refrigeration system and the product compartment. The ventilation system may include a valve positioned in communication with the product compartment. A heater may be positioned about the product compartment. The valve and the heater may be selectively activated such that product compartment may be hot or cold.

[0009] The hot and cold vending machine further may include a number of product compartments and the ventilation system may include a number of valves. The vending machine may have a number of hot compartments and a number of cold compartments. The product compartment

may include a number of product bins. The product bins may include vents positioned therein. The product compartments may be positioned vertically or horizontally.

[0010] The ventilation system may include a supply air duct on a first side of the product compartment and a return air duct on a second side of the product compartment. A first valve may be positioned about the supply air duct and a second valve may be positioned about the return air duct. The valve may include a butterfly valve.

[0011] The refrigeration system may include a removable refrigeration cassette. The refrigeration system may include a refrigeration device. The refrigeration device may include a Stirling cycle cooler, a Rankine cycle device, or any similar type of device. The refrigeration system may include a heat exchanger in communication with the refrigeration device. The refrigeration system may include a fan positioned adjacent to the heat exchanger. The refrigeration system may include a ventilation pathway in communication with the ventilation system.

[0012] A further embodiment may provide for a hot and cold vending machine. The vending machine may include a number of product compartments, a refrigeration system, and a ventilation system in communication with the re-

frigeration system and the product compartments. The ventilation system may include a number of valves such that one or more of the valves are positioned about each of the product compartments. A heater may be positioned within each of the product compartments. The valves and the heaters may be selectively activated.

[0013] The hot and cold vending machine may have a number of cold compartments and a number of hot compartments. The refrigeration system may be removable.

[0014] A method of the present invention may provide for operating a vending machine with a number of product compartments. Each of the product compartments may include a heater therein. The vending machine may have a refrigeration system in communication with each of the product compartments via a ventilation system. The method may include the steps of determining which of the product compartments are to be hot and which of the product compartments are to be cold, opening or confirming that the ventilation system in communication with those product compartments that are to be cold is open, and closing or confirming that the ventilation system in communication with those product compartments that are to be hot is closed.

[0015] The method further may include the steps of turning on the heater in those product compartments that are to be hot and circulating chilled air from the refrigeration system through those product compartments that are to be cold via the ventilation system. The method also may include the steps of determining which of the product compartments are be at room temperature and closing or confirming that the ventilation system in communication with those product compartments that are to be at room temperature is closed.

[0016] These and other features of the present invention will become apparent upon review of the following detailed description when taken in conjunction with the drawings and the appended claims.

Brief Description of Drawings

[0017] Fig. 1 is a front plan view of a hot and cold vending machine of the present invention.

[0018] Fig. 2 is a front cross-sectional view of the hot and cold vending machine of Fig. 1.

[0019] Fig. 3 is a top cross-sectional view of the hot and cold vending machine of Fig. 1.

[0020] Fig. 4 is a side cross-sectional view of one of the compartments of the hot and cold vending machine of Fig. 1.

[0021] Fig. 5 is a perspective view of an alternative embodiment of a hot and cold vending machine.

[0022] Fig. 6 is perspective view of a product area of the hot and cold vending machine of Fig. 5.

DETAILED DESCRIPTION

[0023] Referring now to the drawings, in which like numerals indicate like elements throughout the several views, Figs. 1-4 show an example of a hot and cold vending machine *100* of the present invention. The hot and cold vending machine *100* may include an insulated shell*110*. The insulated shell *110* may be made out of expanded polystyrene foam, polyurethane foam, or similar types of insulating materials. The insulated shell *110* may take any desired size or shape.

[0024] The insulated shell *110* may include a refrigeration cassette area *120* and a product area *130*. The refrigeration components, as described in more detail below, may be positioned within the refrigeration cassette area *120*. The refrigeration cassette area *120* and the product area *130* generally are in communication with one another so as to circulate chilled air from the refrigeration cassette area *120* through the product compartment*130* and back again.

[0025] The product area *130* may have a number of hot and cold

vending compartments *140*. By "hot and cold" vending compartments *140*, we mean "hot and/or cold". In this example, three (3) hot and cold compartments *140* are shown, a first compartment *141*, a second compartment *142*, and a third compartment *143*. Any number of hot and cold compartments *140* may be used. Each hot and cold compartment *140* in turn may be subdivided into any number of individual product bins *150*. Each of the product bins *150* may have a door *160*. Operation of the product doors *160* may be controlled in a conventional manner upon the payment of the appropriate amount of money or upon any other type of conventional triggering event.

[0026] A product or products *170* may be positioned within each product bin *150*. The product *170* may be any type of dispensable item that is intended to be served hot, cold, or at room temperature. For example, a soft drink or an ice cream product may be offered cold; a coffee or a soup product may be offered hot; and potato chips, candy, or other types of items may be offered at room temperature.

[0027] The product area *130* may include a ventilation system *180* so as to circulate chilled air therethrough. The ventilation system *180* may include a number of insulated air ducts *185*. The ducts *185* may be made out of plastic, metal, or

similar types of materials. The air ducts *185* may include a supply air duct *190*. The supply air duct may be in communication with the refrigeration cassette area *120*. In turn, each hot and cold compartment *140* may have a supply compartment duct *200* in communication with the supply air duct *190*. Any number of supply compartment ducts *200* may be used.

[0028] Each hot and cold compartment *140* also may have a number of internal vents *210* positioned between each of the product bins *150*. The ventilation system *180* also may include a number of return compartment ducts *230* in communication with each hot and cold compartment *140*. Any number of return compartment ducts may be used. The ventilation system *180* also may have a return air duct *220*. The return air duct *220* may be in communication with each of the return compartment ducts *200* and the refrigeration cassette area *120*.

[0029] The ventilation system *180* thus includes a pathway from the refrigeration cassette area *120* through the supply air duct *190*, into each of the supply compartment ducts *200*, through each hot and cold compartment *140*, out each return compartment duct *230*, through the return air duct *220*, andback to the refrigeration cassette area. Any simi-

lar type of ventilation path or circulation scheme also may be used herein.

[0030] The ventilation system *180* also may include a supply air valve *240* positioned within each supply compartment duct *200* and a return air valve *250* positioned within each return compartment duct *230*. The valves *240*,*250* may be a conventional butterfly valve *260*. Specifically by use of the term "valve", we mean any type of on-or-off or open-and-shut damper or a similar type of device. Alternatively, each product bin *150* may have its own set of valves *240*, *250*.

[0031] Each hot and cold compartment *140* also may include a heater *270*. The heater*270* may be any type of resistance heater or a similar type of device. The heater may be selectively activated. Further, the heater *270* only may be turned on when a hot product *170* is selected. Alternatively, each product bin *150* may have its own heater.

[0032] Positioned within the refrigeration cassette area *120* may be a refrigeration cassette *300*. The refrigeration cassette *300* may include one or more refrigeration devices *305* positioned therein. The refrigeration device *305* may be a Stirling cycle cooler, a Rankine cycle device, a trans-critical carbon dioxide cycle system, or any other type of re-

frigeration system.

[0033] For example, the refrigeration device *305* may be a Stirling cycle cooler *310*. One type of Stirling cycle cooler *310* that may be used herein is a free piston Stirling cooler. Such a Stirling cycle cooler *310* may be commercially available from Global Cooling, Inc. of Athens, Ohio under the designation "M100B". Similar types of devices also may be used herein.

[0034] The Stirling cycle cooler *310* may include an acceptor or a cold end *320* and a rejector or a hot end *330*. A regenerator *340* may separate the cold end *320* from the hot end *330*. As is known, the Stirling cycle cooler *310* may include a piston driven by a linear motor. The piston and the linear motor may be positioned within a shell *350* and a heat-rejection shroud *360* may surround the shell *350*. A fan *370* or other type of air movement device may be positioned about the shroud *360*. The fan *370* may direct a flow of ambient air across the hot end *330* of the Stirling cycle cooler *310*. The functions of the Stirling cycle cooler *310* and its internal components are well known to those skilled in the art. The respective sizes and numbers of the Stirling cycle coolers *310* and the components therein may vary within the specific application and the operating en-

vironment of the hot and cold vending machine *100* as a whole.

[0035] The refrigeration cassette *300* itself may include a refrigeration device area. The refrigeration device *305* may be positioned within the refrigeration device area *380*. The refrigeration device area *380* may include vents *390* or other types of inlets and outlets as appropriate that may communicate with the insulated shell *110* and the exterior thereof.

[0036] The refrigeration cassette *300* also may include an insulated area *400*. The insulated area *400* may be made out of polyurethane foam, expanded polystyrene foam, or similar types of insulating materials. The insulated area *400* may include a ventilation pathway *410*. The ventilation pathway *410* may have a cold air duct *420* in communication with the supply air duct *190* of the ventilation system *180* of the product area *130*. The insulated area *400* also may have an exhaust air duct *430*. The exhaust air duct *430* may be in communication with the return air duct *220* of the ventilation system *180* of the product area *130*.

[0037] Also positioned within the ventilation pathway *410* of the insulated area *400* may be a heat exchanger *440*. The heat exchanger*440* may be a conventional tube and fin type

heat exchanger, a microchannel heat exchanger, or any similar type of heat exchange device. A fan *445* or a similar type of air movement device may be positioned within ventilation pathway *410* so as to circulate air therethrough.

[0038] The cold end *320* of the Stirling cycle cooler *310*, or whatever refrigeration device *305* that may be used, may be positioned within a heat transfer loop *450* with the heat exchanger *440*. Any type of conventional heat transfer loop *450* may be used. A conventional heat transfer fluid may be used therein. A refrigeration device heat exchanger *460* may be positioned about the refrigeration device *305*. The heat exchanger *440* within the ventilation pathway *410* may be connected by the heat transfer loop *450* with the refrigeration device heat exchanger *460*. The heat transfer loop *450* may circulate the heat transfer fluid therein via a pump *470* or other type of transfer device.

[0039] In the case of the Stirling cycle cooler *310*, the heat transfer loop *450* may be in the form of a thermosiphon as described in detail in commonly-owned U.S. Patent No. 6,550,255, incorporated herein by reference. Any similar type of heat transfer loop *450* may be used herein.

[0040] As described above, the refrigeration cassette *300* may be similar to that described in commonly owned U.S. Patent

No. 6,581,389, incorporated herein by reference. The refrigeration cassette *300* may be removable from the insulated shell *110* and the ventilation system *180*. One or more seals *480* may be positioned about the ducts *420* or *430* so as to provide efficient airflow between the refrigeration cassette area *120* and the product area *130*. The seals *480* may be made out of vinyl extrusion, elastomeric foam, or similar types of materials.

[0041] In use, a determination is made of which hot and cold compartments *140* may be hot, which may be cold, and which may be at room temperature. For example, it may be determined that the first compartment *141* and the second compartment *142* will be cold and that the third compartment *143* will be a hot. If so, then the valves *240*, *250* within the compartment ducts *200*, *230* are opened in the first and second compartments *141*,*142*. Likewise, the valves *240*, *250* in the compartment ducts *200*, *230* of the third compartment *143* are closed.

[0042] The heater *270* within the third compartment *143* or within an individual product bin *150* then may be activated. Alternatively, the heater *270* may remain off until a particular product *170* is selected. The refrigeration device *305* also may be activated such that the refrigeration device

305 cooperates with the heat exchanger *440* via the heat transfer loop *450* to remove heat within the air passing through the ventilation pathway *410*. The fan *445* then circulates the chilled air through the cold air duct *420*, into the supply air duct *190*, and into the supply compartment ducts *200* of the first and second compartments *141*, *142*. The chilled air then cools the products within the compartments *141*, *142* and within each product bin *150*. The exhaust air then exits the compartments *141*, *142* via the return compartment air ducts *230*, the return air duct *220*,and back into the ventilation pathway *410* via the exhaust air duct *430*.

[0043] Meanwhile, the closed valves *240*, *250* within the compartment ducts *200*, of the third compartment *143* isolate the third compartment *143* from the cold airflow. At least the valve *240* should be closed. The heater *270* may warm the products *170* within the product bins *150*.

[0044] Each of the compartments *140* may be heated or chilled depending on the desired inventory of products *170* within the hot and cold vending machine *100*. Likewise, one of the compartments *140* also may be maintained at room temperature by closing off the valves *240*, *250* but not turning on the heater *270*. The number of hot and cold

compartments *140* may be altered between hot, cold, or room temperature at any time.

[0045] The refrigeration cassette *300* may be removed so as to make the refrigeration unit *305* easily accessible for replacement, repair, or maintenance. The ventilation system *180* and the product area *130* need not be disturbed.

[0046] Figs. 5 and 6 show an alternative embodiment, a hot and cold vending machine *500*. The vending machine *500* is similar to the hot and cold vending machine *100* described above, but in this case the vending machine *500* has three vending areas *510*, *520*, *530*. Hot or cold products *170* may drop into one of the vending areas *510*, 520, *530*. Any number of the vending areas *510*, *520*, *530* may be used.

[0047] Figs. 6 shows a product area *540* of the vending machine *500*. The product area *540* of the vending machine *500* also may have a number of hot and cold compartments *550*. In this case, a first hot and cold department *551*, a second hot and cold compartment *552*, and a third hot and cold compartment *553*. The hot and cold products *170* may be stacked vertically within each hot and cold compartment *550*. Each hot and cold product compartment *550* may include a conventional drop mechanism so as to drop the hot or cold products *170* to the vending areas *510*, *520*,

530.

[0048] As described above, each hot and cold compartment *550* may be connected to the ventilation system *180*. Specifically, the ventilation system *180* includes the circuit from the refrigeration cassette area *120* through the supply air duct *190*, into each of the supply compartment ducts *200*, through selected hot and cold compartment *550*, out each return compartment duct *230*, through the return air duct *220*, and back to the refrigeration cassette area *120*. A supply air valve *240* may be positioned within each supply compartment duct *200* and a return air valve *250* may be positioned within each return compartment duct *230*. The valves *240*, *250* may be open or shut so as to heat or cool each hot or cold compartment *550* as described above.

[0049] It should be apparent that the foregoing relates only to exemplary embodiments of the present invention and that numerous changes and modification may be made herein without departing from the spirit and scope of the invention as defined by the following claims and the equivalents thereof.